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Comparison of growth between Browns Bank/ Scotian Shelf Area and Georges Bank/ Gulf of Maine area: A Data Report

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Comparison of Growth Between Browns Bank/

Scotian Shelf Area and Georges Bank/

Gulf of Maine: A Data Report

Ultimately, growth depends on availability and utilization of food. Growth differences are under the influence of physical environmental factors. For example, average temperature (e.g., bottom for flatfish) for a geographic area influences metabolism directly and also the availability of prey both in quantity and type. Growth differences are thus indicators of different ecological areas. Generally, the fish considered here, grow more slowly in the colder northern waters of the Scotian Shelf area.

1. For haddock, cod, and yellowtail, the growth rates are considerably different for the Georges and Browns Bank areas. For all three species, the growth rate is considerably slower on Browns Bank than on Georges Bank.
2. Colder temperatures of the Scotian Shelf tend to be correlated with lower growth rates (K) and higher asymptotic length (L_∞) of sea herring when compared to Georges Bank and the Gulf of Maine.
3. Growth estimates for silver hake indicate differences in growth between the two major areas but with the reverse trend in K and L_∞ as described in 2 above.
4. Gulf of Maine American plaice grow faster than those on fishing banks further north, e.g. Nova Scotia.
5. Redfish are slow-growing, long-lived fish which grow faster in the Gulf of Maine then they do on the Scotian Shelf.

Summary of Haddock Growth Data

Large differences were found in the age compositions of haddock taken on Georges and Browns Bank during a research cruise in June 1949 (Figure 1). There were also highly significant differences in the average size of the same ages of haddock taken on the two banks, indicating a marked difference in the rate of growth of haddock from these two areas (Table 1). This difference indicates that hereditary or ecological conditions governing growth are different in the two areas and that important intermigrations of the bottom dwelling stages of haddock do not occur (Schuck and Arnold 1951).

Martin (1953) states that the slowest growing haddock of Subarea 4 are resident on Browns Bank and that this population differs sharply from that of Georges Bank.

Wise (1957) states: A study of the growth rate of Browns Bank haddock, by a method of back-calculations from haddock scales (Table 1) taken from fish that ranged in age from 4 to more than 10 years old, reveals that the growth rate is considerably slower than that for haddock on Georges Bank, but faster than that previously determined for haddock from Nova Scotia (Figure 2).

Penttila (unpublished data) calculated mean lengths at age for haddock from spring survey cruise age sample data pooled over years (1973 through 1978) for each area (Table 1).

Summary of Atlantic Cod Growth Data

Schroeder (1930) estimated average length at age for Southern New England cod by back-calculating scales (Table 1) and by age-length keys of cod which were caught and aged.

Penttila and Gifford (1976) determined mean lengths at age for cod from Georges Bank and Gulf of Maine (Table 1). Penttila (unpublished data) calculated mean lengths at age for cod from survey cruise age sample data pooled over years (1970 through 1979) for each season and area (Table 1).

Summary of Yellowtail Flounder Growth Data

Scott (1954) states that Cape Cod yellowtail differed in all respects (i.e., rate of growth (Figure 3), sexual maturity, age and size composition, otolith growth, relative growth of three body parts and meristic characters) from fish from two Nova Scotia fishing areas, Middle Ground and Western Bank (Table 1). He concluded that in 1946 the Cape Cod yellowtail formed a distinct population.

Royce, Buller, and Premetz (1959) state that the Nova Scotian stock of yellowtail is completely distinct from the New England stocks (i.e., Southern New England, Georges Bank, Cape Cod, and northern Gulf of Maine (Table 1).

Lux and Nichy (1969) determined that length at age of yellowtail flounder differs slightly on the three grounds off New England (Southern New England, Georges Bank, and Cape Cod) (Table 1). The growth rate from age 2 onward for males and females combined for Southern New England and Georges Bank is estimated by the Bertalanffy equation $L_t = 500 (1 - e^{-0.335 (t+0.26)})$.

For haddock, cod, and yellowtail the growth rates are considerably different for the Georges and Browns Bank areas. For all three species, the growth rate is considerably slower on Browns Bank than on Georges Bank. Growth of these species on Georges Bank is more similar to growth in the Gulf of Maine and Southern New England than it is to the Scotian Shelf.

Sea Herring

A survey of von Bertalanffy growth estimates by Anthony (1972), Anthony and Waring (1980a) and Slepokurov (1975) clearly indicate differences in growth between Atlantic herring of Georges Bank and the Scotian Shelf. Although growth estimates by Draganik (1966), Draganik and Zukowski (1967), and Chrzan and Draganik (1968) are available for Georges Bank, growth calculations were based upon ages for a single sampling year and, therefore, not considered as acceptable by the ICNAF herring assessment working group (Anthony, pers. comm.).

Growth differences between Georges Bank and Scotian Shelf herring are probably due to variation in water temperature (Anthony, pers. comm.). Colder temperatures of the Scotian Shelf tend to result in lower growth rates (K) of .179 to .23 and higher asymptotic fish lengths (L_∞) of 39.0 to 41.0 cm. Warmer water temperatures of Georges Bank result in higher K's of .347 to .377 and lower L_∞'s of 34.1 to 34.5 cm. (Table 2).

Silver Hake

Von Bertalanffy growth equations for silver hake have been reported by Almeida (1978) for Georges Bank and the Gulf of Maine, and by Hunt (1978) for the Scotian Shelf. A comparison of mean lengths at age calculated from the above equations indicate significant differences between the three areas at all ages except age 4 (Table 3). Figure 4, a plot of the growth curves based on these data, further outlines these differences. To summarize, Hunt's data for Scotian Shelf hake indicate a higher growth rate (K) and lower L_∞ in comparison with data of Almeida for hake of Georges Bank and Gulf of Maine.

Red Hake

Age and growth data are solely available from Richter (1968) and indicate differences in growth rate over the first two years (ages 1-2) between red hake of the Scotian Shelf and those of three other areas located on the northern edge of Georges Bank, southwest edge of Georges, and Mid-Atlantic. Figure 5 is reproduced from this paper and indicates that young red hake (females) from Nova Scotia are clearly the slowest growing of the four groups. Results of morphometric analysis and an otolith study in this document provide some evidence for separation of the four stocks. United States age and growth data, however, is not yet available for comparative purposes.

Redfish

For many years, considerable controversy has surrounded the question of redfish age and growth. Even though redfish release live young as compared to most fish which release thousands of eggs to be externally

fertilized, Katthaus (1958) considered their growth rate to be not very different from that of most fish species with external incubation. However, Perlmutter and Clark (1949), Bratberg (1956), Kelly and Wolf (1959), Sandeman (1961, 1969), Mayo (1980), Clay and Clay (1980), and Mayo et al. (1981) have contributed substantial evidence supporting the hypothesis that redfish are long-lived, slow-growing fish, which is presently a widely-held tenet of redfish biology.

Both Mayo (1980) and Clay and Clay (1980) utilized research vessel survey data to estimate growth of redfish from the Gulf of Maine and the Scotian Shelf, respectively. In both studies, growth parameters for male and female redfish, and for sexes combined, were derived from von Bertalanffy growth curves, fitted, using the computer program (BGC-2) developed by Tomlinson and Abramson (1961), to individual fish length-at-age observations. However, even though the form of the von Bertalanffy growth curves are the same, rate of growth is slower for the Scotian Shelf redfish than for the Gulf of Maine as indicated by a lower K value reported by Clay and Clay (1980) (Table 4). Mayo (1980) reported a higher K value and a lower value for L_∞ which is just the reverse of that reported by Clay and Clay (1980). Growth for Gulf of Maine as reported by Kelly and Wolf (1959) was more similar to that reported by Mayo (1980) for the same area than to the Scotian Shelf redfish.

American Plaice

In light of a developing fishery for American plaice in the Gulf of Maine, growth information is essential to good resource management. Both Lux (1970) and Sullivan (1982) reported higher growth rates (K) for American

plaice from the Gulf of Maine than did Halliday (1973) for those found on the Scotian Shelf (Table 5). Pitt (1967) compared growth rates of female American plaice over most of the geographic range of the species (Figure 6). He found that the fastest growing fish are those in the Gulf of Maine.

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Table 1. Comparison of growth data for haddock, cod, and yellowtail flounder.

Investigator and area \ Age	1	2	3	4	5	6	7	8	9
				Mean Lengths at Age (in cm)					
				Haddock					
Serchuk + Arnold (1951)									
Georges	22.7	36.6	43.2	49.4	52.4	59.1	-	62.0	72.0
Browns	17.9	22.4	30.6	41.1	46.4	51.6	52.7	59.0	63.0
Wise (1957)									
Browns	17.5	27.2	35.6	42.7	47.6	52.3	54.6	57.6	61.3
Penttila (unp.)									
Nauset	23.51	39.77	51.54	58.08	65.24	68.43	71.00	71.00	-
Georges	25.04	40.09	49.93	57.05	61.82	66.68	65.13	72.63	71.67
Gulf of Maine	19.76	35.28	47.11	53.44	59.19	61.58	68.00	-	64.50
Browns	18.92	29.29	39.64	48.17	53.78	58.44	60.14	64.08	65.89
Scotian Shelf	16.82	28.58	38.82	47.04	53.59	57.90	60.19	63.32	63.50
				Cod					
Schmeder (1930)									
Nantucket Shoals	17.0	38.4	52.8	63.0	70.4	79.0	85.3	91.7	98.3
Penttila and Gifford (1976)									
Georges	22.43	44.09	57.95	66.50	74.87	79.78	86.93	93.20	103.10
Gulf of Maine	14.94	26.85	39.63	57.87	68.04	76.09	78.18	86.82	94.17
Penttila (unp.)									
South + Nauset	21.90	40.65	56.95	70.86	77.96	85.02	93.13	95.95	101.05
Georges	23.88	44.10	58.82	67.75	75.98	82.73	89.15	94.47	102.88
Gulf of Maine	18.14	31.01	41.86	54.95	66.50	77.37	84.12	92.18	96.26
Browns	17.82	34.90	48.60	60.05	69.79	79.28	84.05	86.86	102.17
Scotian	13.68	28.69	46.67	58.54	65.10	70.65	78.00	91.17	88.63
Martin (1953)									
Lockeport	-	-	-	51	57	65	71	75	84
Middle Ground	-	-	-	-	54	61	65	72	79

Table 1. Cont'd.

Penttila (unpublished)

COD MEAN LENGTHS AT AGE (in cm.)

SPRING

Area \ Age	0	1	2	3	4	5	6	7	8
South & Nauset	5.00	21.90	40.65	56.95	70.86	77.96	85.02	93.13	95.95
Georges Bank	4.83	23.88	44.10	58.82	67.75	75.98	82.73	89.15	94.47
Gulf of Maine	4.50	18.14	31.01	41.86	54.95	66.50	77.37	84.12	92.18
Browns Bank	4.00	17.82	34.90	48.60	60.05	69.79	79.28	84.05	86.86
Scotian Shelf	5.00	13.68	28.69	46.67	58.54	65.10	70.65	78.00	91.17

SPRING

Area \ Age	9	10	11	12	13	14	15	16	17
South & Nauset	101.05	102.38	106.50	116.20	113.00		110.50		
Georges Bank	102.88	105.00	117.50	120.29	104.33	128.40	120.67	128.00	148.00
Gulf of Maine	96.26	98.97	104.67	111.21	113.30	121.86	117.33	128.33	125.67
Browns Bank	102.17	100.27	107.33	101.00	114.00	113.00	115.00	124.00	
Scotian Shelf	88.63	106.00	97.00	85.00		111.00	128.00	120.00	

Table 1. Cont'd.

AUTUMN

Area \ Age	0	1	2	3	4	5	6	7	8
South & Nauset	12.15	33.62	49.82	61.96	75.09	83.64	89.18	98.85	102.09
Georges Bank	14.42	34.89	51.71	63.45	73.66	79.79	85.51	93.73	95.75
Gulf of Maine	11.33	26.41	37.83	50.09	60.76	71.01	80.92	86.79	97.72
Browns Bank	12.95	28.73	42.56	55.73	63.51	66.43	76.16	85.73	96.33
Scotian Shelf	10.53	24.00	40.33	55.18	66.21	70.14	78.83	81.11	88.55

AUTUMN

Area \ Age	9	10	11	12	13	14	15	16	17
South & Nauset	100.44	110.54	111.50	114.40		115.00			
Georges Bank	101.67								
Gulf of Maine	104.03	110.53	110.44	114.75	117.50	115.20	133.00		
Browns Bank		117.00		150.00	116.00			140.00	
Scotian Shelf	96.00	101.57	105.25	87.50	117.00		127.00	120.00	

Table 1. Cont'd.

Comparison of Yellowtail Flounder Growth Data

Mean Lengths at Age (in cm.)

Yellowtail Flounder

Investigator & Area \ Age	1	2	3	4	5	6	7	8	9
Scott(1954)									
Nova Scotia Middle Ground	-	-	22.0	22.3	29.3	34.6	37.4	40.1	42.3
Nova Scotia Western Bank	-	16.8	21.5	26.6	31.6	36.4	39.9	41.3	42.0
Cape Cod	-	29.1	34.0	34.4	36.3	-	-	-	-
*Royce et al. So. New England (1959)	-	29.1	32.5	35.2	37.2	-	-	-	-
*Lux & Nichy(1969)									
So. New England	11.6	25.4	31.9	35.6	37.2	39.5	42.0	39.0	-
Georges	-	-	-	37.2	38.5	39.2	41.6	40.0	-
Cape Cod									

Yellowtail Flounder

	1	2	3	4	5	6	7	8	9
Scott(1954)									
Nova Scotia Middle Ground	-	-	21.0	23.7	31.3	35.0	39.4	42.8	45.3
Nova Scotia Western Bank	9.2	16.7	21.3	26.0	31.6	36.5	43.8	46.0	46.2
Cape Cod	-	30.2	35.0	37.3	38.8	38.7	42.0	-	-
*Royce et al(1959)									
So. New England	-	30.4	34.2	37.9	40.6	42.2	44.5	-	-
*Lux & Nichy(1969)									
So. New England	11.6	26.6	34.3	38.9	41.8	44.2	46.4	47.0	-
Georges	-	-	-	41.3	43.8	45.3	46.9	47.7	49.5
Cape Cod	-	-	-	41.2	43.9	45.5	46.0	46.0	-

*Data from the 2nd calendar quarter used (April-June).

Table 2. Calculated mean length at age in cm from growth parameters reported by Anthony (1972), Anthony and Waring (1980 a), and Slepokuvov (1975) for Atlantic herring.

AREA	GEORGES BANK		GULF OF MAINE (WEST)	GULF OF MAINE (EAST)	SCOTIAN SHELF	
RESEARCHER	Anthony (1972)	Anthony and Waring (1980a)	Anthony (1972)	Anthony (1972)	Anthony (1972)	Slepokuvov (1975)
YEAR CLASSES	'53-'67	'60-'71	'53-'67	'53-'67	'53-'67	'58-'70
Age (t)						
1	13.0	13.5	10.8	8.3	8.4	9.9
2	19.3	19.9	17.7	15.5	21.8	16.3
3	23.7	24.4	22.7	21.0	24.6	21.4
4	26.9	27.4	26.2	25.1	27.0	25.4
5	29.1	29.5	28.7	28.2	28.9	28.6
6	30.7	31.0	30.6	30.6	30.6	31.2
7	31.8	32.0	31.8	32.4	32.0	33.2
8	32.6	32.6	32.8	33.7	33.1	34.8
9	33.2	33.1	33.4	34.8	34.1	36.1
10	33.6	33.4	33.9	35.6	34.9	37.1
L_∞	34.5	34.1	35.1	38.0	39.0	41.0
k	.347	.377	.335	.277	.179	.23
t_o	-.357	-.331	-.097	.101	-2.56	-0.2

Table 3. Calculated mean length at age in cm from growth parameters reported by Almeida (1978) and Hunt (1978) for silver hake. (*-difference in mean length at age among areas.)

Age "t"	GEORGES BANK Almeida (1978) Comb. Sexes	GULF OF MAINE Almeida (1978) Comb. Sexes	SCOTIAN SHELF Hunt (1978) Males	Females
1	16.7*	13.5*	19.4*	19.7*
2	24.1*	22.1*	27.9*	28.3*
3	29.9*	29.3*	32.1*	32.8*
4	34.5	35.3	34.1	35.2
5	38.0*	40.3*	35.1*	36.5*
6	40.8*	44.5*	35.6*	37.1*
7	42.9*	48.0*	35.8*	37.5*
L_∞	50.72	65.41	36.01	37.88
k	.246	.182	.72	.638
t_o	-.621	-.275	-0.078	-0.148

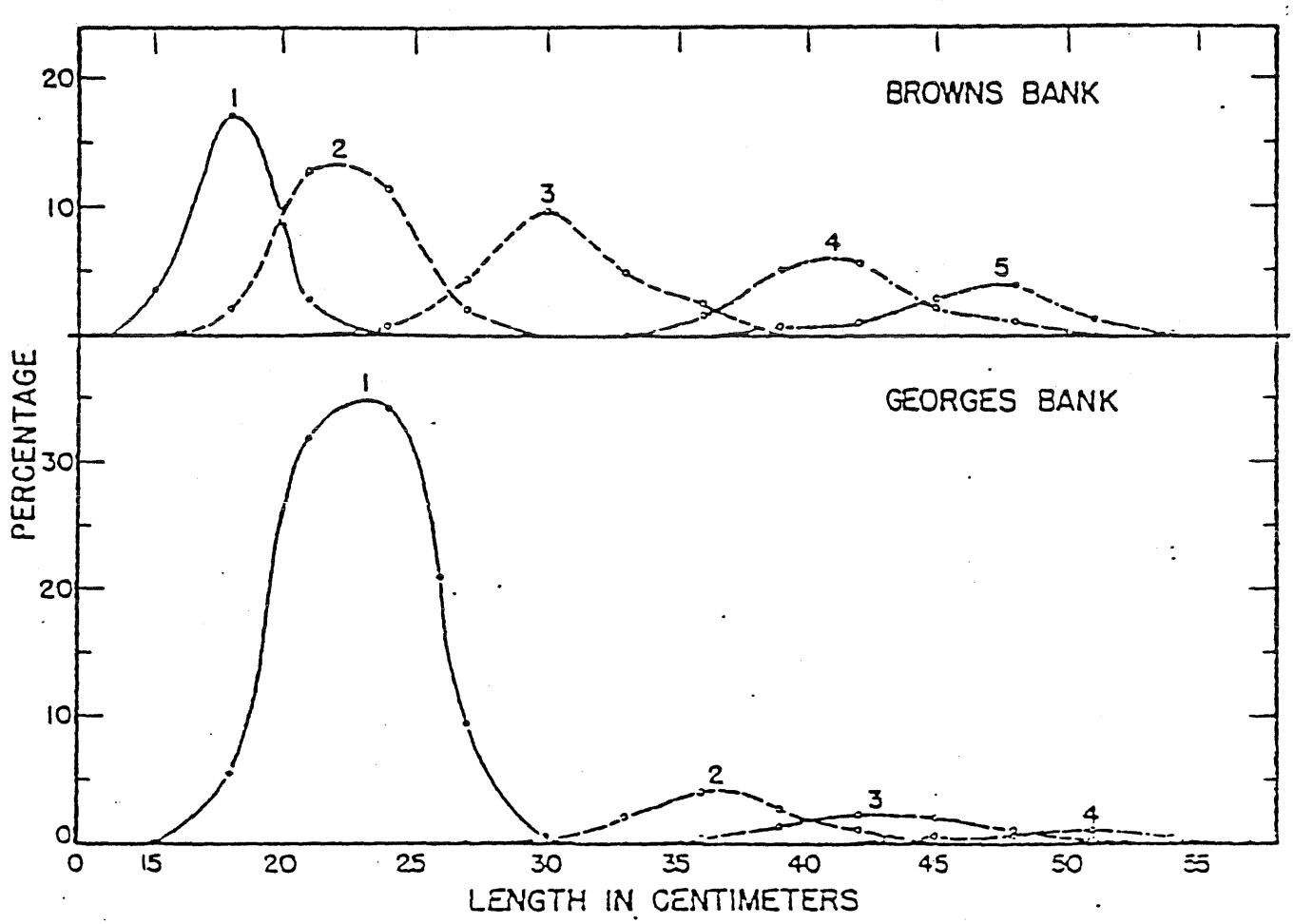
Table 4. von Bertalanffy growth parameters for redfish.

	L_∞ (cm)	k	t_o	N	
Gulf of Maine	37.80 ± 0.24	0.1049 ± 0.0037	-2.88 ± 0.22	3,186	Mayo (1980)
	41.60 ± 1.30	0.0927 ± 0.0069	-0.19 ± 0.18		Kelly and Wolf (1959)
Scotian Shelf	53.32	0.047	-1.26	1,443	Clay and Clay (1980)

Table 5. Calculated mean length at age in cm from growth parameters reported by Lux (1970), Sullivan (1982) and Halliday (1973) for American plaice.

	W. GULF OF MAINE		GULF OF MAINE		SCOTIAN SHELF	
	Lux (1970)		Sullivan (1982)		Halliday (1973)	
Age (t)	M	F	M	F	M	F*
1	6.6	8.5	9.0	8.9	13.5	
2	15.7	16.7	17.0	17.6	16.8	
3	22.6	23.8	23.7	24.8	19.8	
4	27.9	29.9	29.3	31.0	22.5	
5	32.0	35.1	34.1	36.2	24.9	
6	35.0	39.6	38.1	40.6	27.0	
7	37.4	43.5	41.5	44.3	28.9	
8	39.2	46.9	44.4	47.4	30.6	
9	40.6	49.7	46.8	50.0	32.1	
10	41.6	52.2	48.8	52.2	33.5	
L_∞	45.0	67.5	59.8	64.2	44.6	
k	0.27	0.15	0.17	0.17	0.114	
t_o	0.41	0.10	0.04	0.12	-2.16	

*data for females cannot be estimated from growth equation.



—Percentage age compositions of haddock catches from Georges and Browns Banks.

Figure 1. From Schuck and Arnold, 1951.

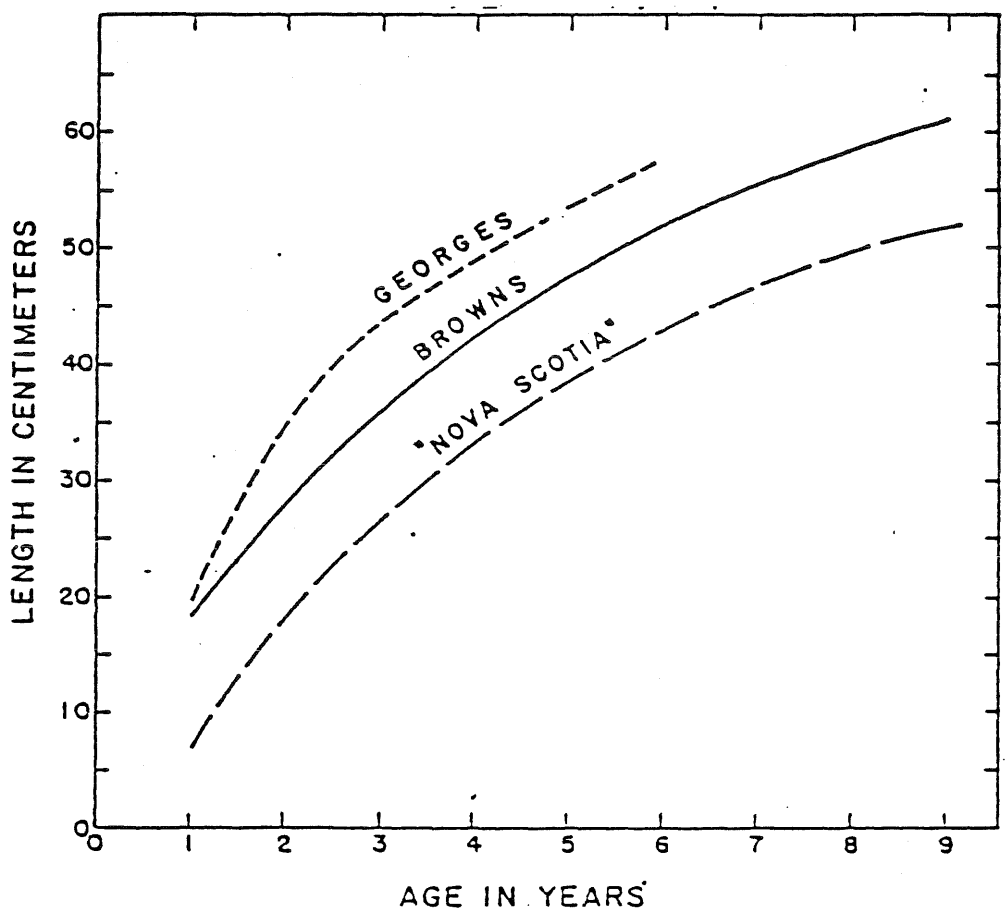


Figure 2—Comparison of haddock growth rates.

Figure 2 shows the Browns growth curve compared with one for Georges Bank (Graham 1952) and one given by Thompson (1939) for Nova Scotia. (Although Thompson does not mention the source of his samples, we infer that they were from Banquereau exclusively and are, therefore, not necessarily representative of the whole Nova Scotia area.)

Figure 2. From Wise 1957.

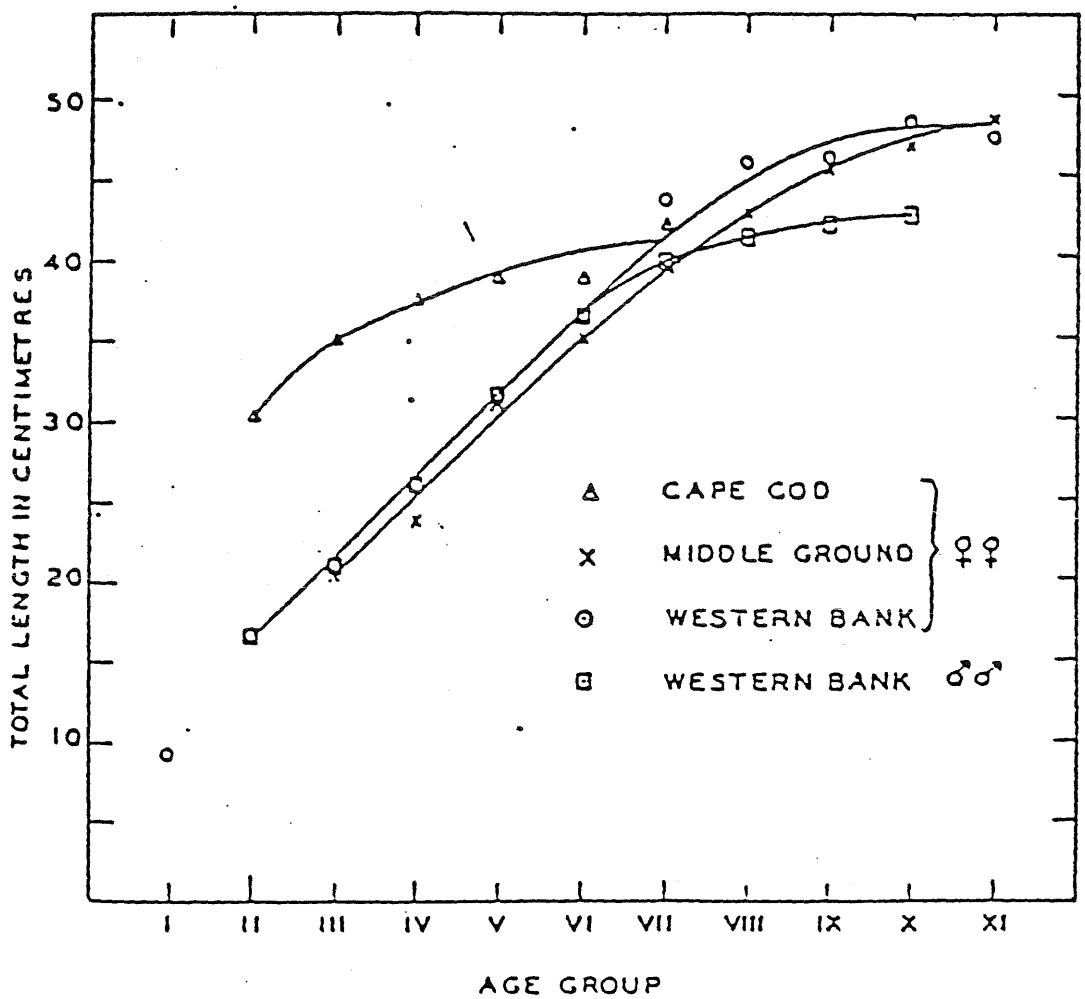
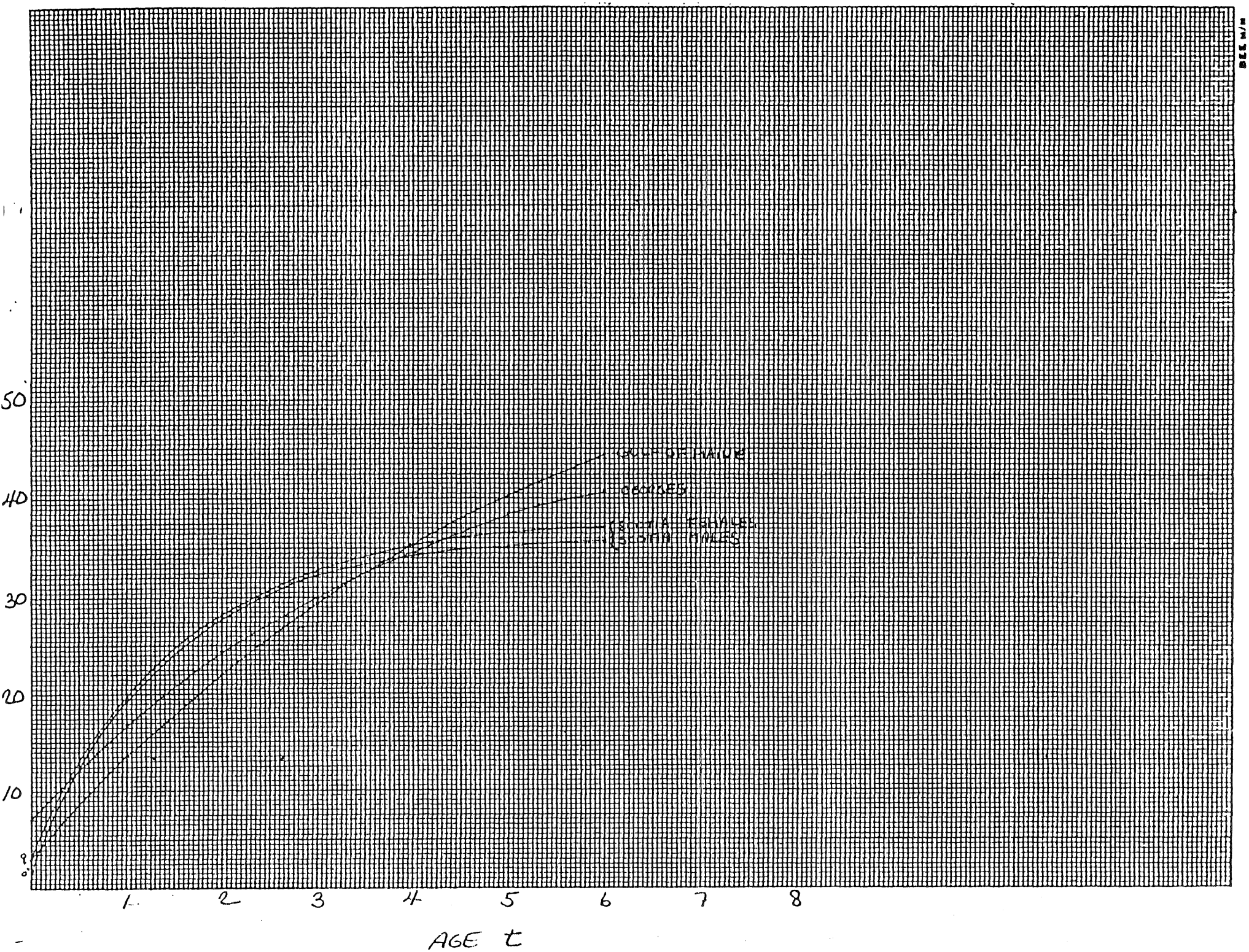


FIGURE 3. Rate of growth in length of female yellowtails from Middle Ground, Western Bank and Cape Cod. Males from Western Bank are also shown.

Figure 3. From Scott 1954.

Figure 7. Growth curves reported by Himelbach (1970) and Hart (1970) for silver hake



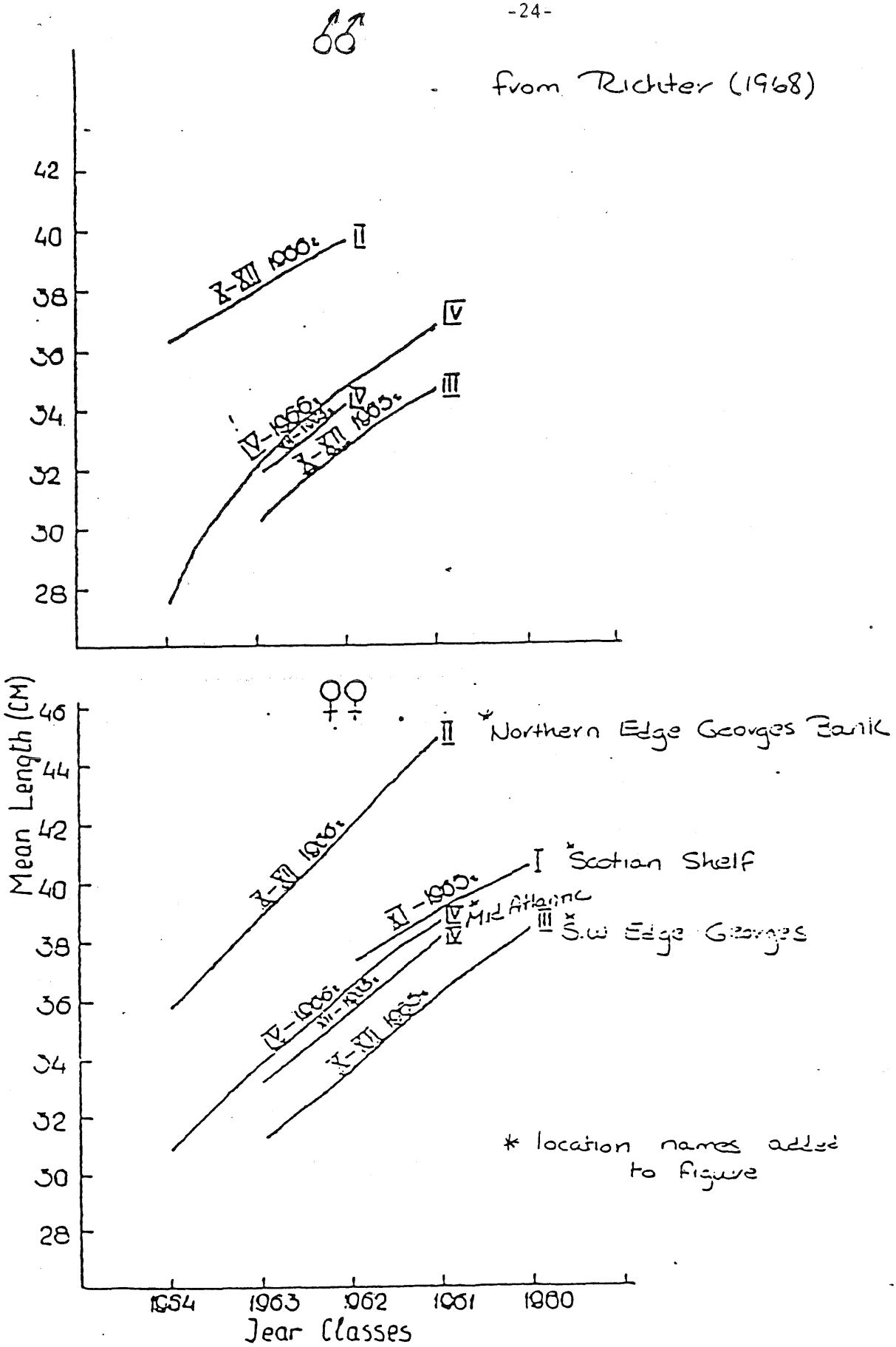


Figure 5. Comparison of red hake between areas.

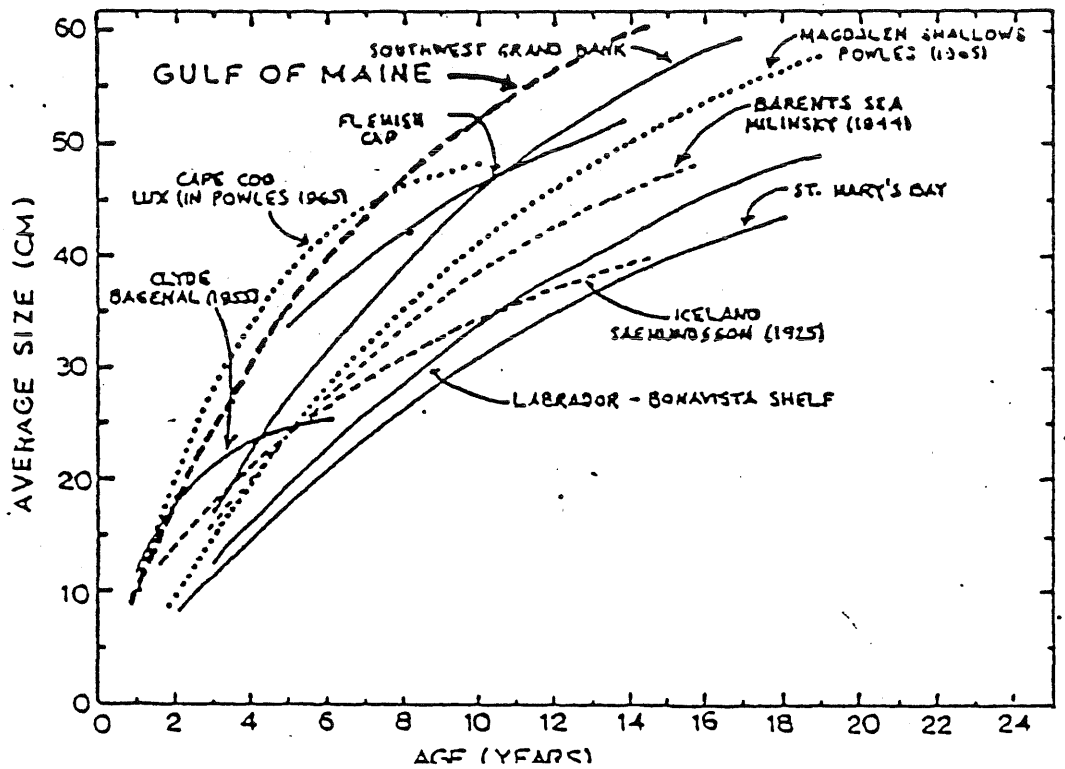


Figure 6. Comparative growth rates, based on von Bertalanffy growth equations, of American plaice from North American locations. (Sullivan, 1952).